

CLAIMS

1. A process for liquefying starch-containing material comprising treating said starch-containing material with at least one alpha-amylase and a maltogenic amylase.
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2. A process for liquefying starch-containing material comprising treating said starch-containing material with at least one amylase and at least one esterase.
3. The process of claim 2, wherein the liquefaction comprises:
10 (a) pre-treating a slurry of said starch-containing material with at least one esterase, and
(b) liquefying the pre-treated slurry with at least one alpha-amylase.
4. The process of any of claim 1-3, wherein the starch-containing material is reduced in
15 size, preferably by dry milling.
5. The process of claim 3, wherein further a maltogenic amylase is present during pre-treatment.
- 20 6. The process of claim 2, wherein the pre-treatment is carried out by subjecting the slurry of starch-containing material with an esterase, preferably a lipase, a maltogenic amylase and an alpha-amylase, preferably an acid amylase, such as a fungal acid alpha-amylase.
- 25 7. The process of claim 3, wherein the amylase is a maltogenic amylase and/or an alpha-amylase.
8. The process of claim 1, wherein the liquefaction is carried out in multi-stages, such as three stages, preferably a first stage at a temperature in the range from 80 to 105°C, a
30 second stage at a temperature in the range between 65 to 95°C, and a third stage at a temperature between 40-75°C.
9. The process of claim 8, wherein the multi stage liquefaction is carries out at the following temperature stages: a first stage: 80-95°C, a second stage: 75-85°C, and third
35 stage: 60 to 70°C.

10. The process of claim 8 or 9, wherein the holding time for stage one is 10 to 90 minutes, 30-120 minutes for the second stage and 30-120 minutes for the third stage.
11. The process of any of claims 1-10, wherein the starch-containing material is treated with an esterase and a maltogenic amylase and/or an alpha-amylase.
12. The process of any of claims 1-11, wherein the starch-containing material is whole grains, preferably corn, wheat, barley, or milo.
13. The process of any of claims 1-12, wherein the amylase or maltogenic amylase is of bacterial origin, preferably a strain of the genus *Bacillus*, especially *Bacillus stearothermophilus*.
14. The process of any of claims 2-13, wherein the esterase is a lipase, phospholipase, or a cutinase, or a combination thereof.
15. The process of any of claims 1-14, wherein liquefaction is carried out in the presence of a fatty acid oxidizing enzyme, preferably a lipoxxygenase.
16. The process of any of claims 1-15, wherein the (pre-)treatment is carried out in an aqueous slurry at a temperature in the range from 20-105°C, preferably 60-95°C.
17. A process for producing a fermentation product, comprising
- (a) reducing the size of starch-containing material;
 - (b) liquefying the product of step (a) with at least one alpha-amylase and at least one maltogenic amylase as defined in claim 1;
 - (c) saccharifying the liquefied material obtained in step (b) with a carbohydrate-source generating enzyme; and
 - (d) fermenting the saccharified material using a fermenting microorganism.
18. A process for producing a fermentation product, comprising
- (a) reducing the size of starch-containing material;
 - (b) liquefying the product of step (a) with at least one amylase and at least one esterase;
 - (c) saccharifying the liquefied material obtained in step (b) with a carbohydrate-source generating enzyme; and

(d) fermenting the saccharified material using a fermenting microorganism.

19. A process for producing a fermentation product, comprising

(a) reducing the size of starch-containing material

5 (b) i) pre-treating a slurry of said starch-containing material with at least one esterase,

ii) liquefying the pre-treated slurry with an alpha-amylase;

(c) saccharifying the liquefied material obtained in step (b) with a carbohydrate-source generating enzyme; and

10 (d) fermenting the saccharified material using a fermenting microorganism.

20. The process of any of claims 17-19, wherein the starch-containing material is reduced in size by dry milling.

15 21. The process of any of claims 17-20, wherein steps b) and c) are carried out as a simultaneous saccharification and fermentation step (SSF).

22. The process of any of claims 17-20, wherein the starch-containing material is whole grains, preferably corn, wheat, barley, or milo.

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23. The process of claim 19, wherein the pre-treatment in step (b) i) is further carried out in the presence of a maltogenic amylase.

24. The process of any of claims 17-23, wherein the carbohydrate-source generating
25 enzyme is a glucoamylase or an alpha-amylase of mixtures thereof, preferably in mixture of acidic fungal alpha-amylase activity (AFAU) per glucoamylase activity (AGU) (AFAU per AGU) of at least 0.1, in particular at least 0.16, such as in the range from 0.12 to 0.50.

25. The process of any of claims 17-24, further comprising distilling the fermented
30 material.

26. The process of any of claims 17-25, wherein said fermenting microorganism is yeast.

27. The process of any of claims 17-26, wherein the treatment or pre-treatment is carried
35 out in aqueous slurry at a temperature in the range from 20-105°C, preferably 60-95°C.

28. The process of any of claims 19-27, wherein further a maltogenic amylase is present during pre-treatment.

29. The process of any of claims 19-28, wherein the pre-treatment is carried out by
5 subjecting the slurry of starch-containing material with an esterase, preferably a lipase, a maltogenic amylase and an alpha-amylase, preferably an acid amylase, such as a fungal acid alpha-amylase.

30. The process of any of claims 19-29, wherein the amylase is a maltogenic amylase
10 and/or an alpha-amylase.

31. The process of any of claims 17-30, wherein the liquefaction is carried out in multi-
stages, such as three stages, preferably a first stage at a temperature in the range from 80
to 105°C, a second stage at a temperature in the range between 65 to 95°C, and a third
15 stage at a temperature between 40-75°C.

32. The process of claim 31, wherein the multi stage liquefaction is carried out at the
following temperature stages: a first stage: 80-95°C, a second stage: 75-85°C, and third
stage: 60 to 70°C.
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33. The process of claim 31 or 32, wherein the holding time for stage one is 10 to 90
minutes, 30-120 minutes for the second stage and 30-120 minutes for the third stage.

34. The process of any of claims 17-33, wherein the starch-containing material is treated
25 with an esterase and a maltogenic amylase and/or an alpha-amylase.

35. The process of any of claims 17-34, wherein the starch-containing material is whole
grains, preferably corn, wheat, barley, or milo.

30 36. The process of any of claims 17-35, wherein the amylase or maltogenic amylase is of
bacterial origin, preferably a strain of the genus *Bacillus*, especially *Bacillus*
stearothermophilus.

37. The process of any of claims 18-36, wherein the esterase is a lipase, phospholipase,
35 or a cutinase, or a combination thereof.

38. The process of any of claims 17-37, wherein liquefaction is carried out in the presence of a fatty acid oxidizing enzyme, preferably a lipxygenase.
39. The process of any of claims 18-38, wherein the (pre-) treatment is carried out in an aqueous slurry at a temperature in the range from 20-105°C, preferably 60-95°C.
40. The process of any of claims 17-39, wherein the fermentation product is ethanol.